Bark-Activated Automatic Dog Door

Design Review

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1.0 Introduction

1.1 Purpose

The purpose of our project is to provide a simple system for dog owners to let their dogs in and out of the house without leaving the couch or while away from home. When signalled by a bark, the system will take a picture of the inside and outside of the door and email them to the owner. Once the owner receives the email, they will be able to respond and either open the door or leave it closed based on the pictures. This allows the owner to remotely let the dog in or out with the comfort of knowing what is going through the door.

1.2 Objectives

1.2.1 Goals

- Provide remote monitoring and control of a door
- Through DSP achieve recognition of a dog bark on a microcontroller
- Create a discreet package that can be retrofit onto existing sliding doors

1.2.2 Functions

- Notify user of dog's intent to go outside
- Send picture of both sides of door with notification
- Open and close door remotely based on email response

1.2.3 Benefits

- Allow pets out more often when away from home
- Let pets out without leaving your couch or bed
- Know what's on both sides of your door before opening it
- Decrease of heating and cooling cost with more intelligent opening and closing system

1.2.4 Features

- Optical sensors to prevent door closing on your dog
- Motion and bark detection to eliminate unnecessary notifications
- Know whether your dog is inside or outside

2.0 Design

2.1 Block Diagrams

2.1.1 Hardware Block Diagram

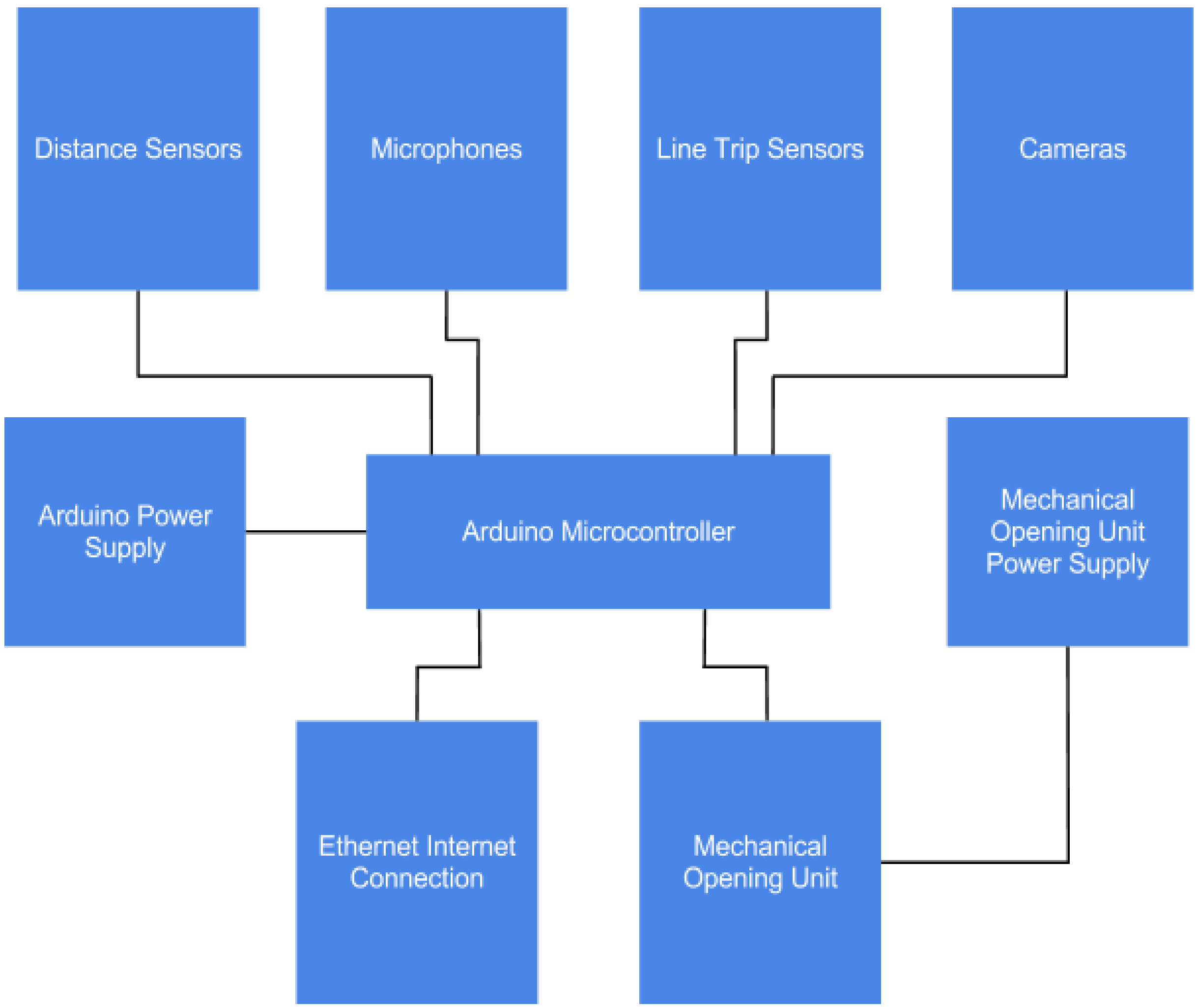
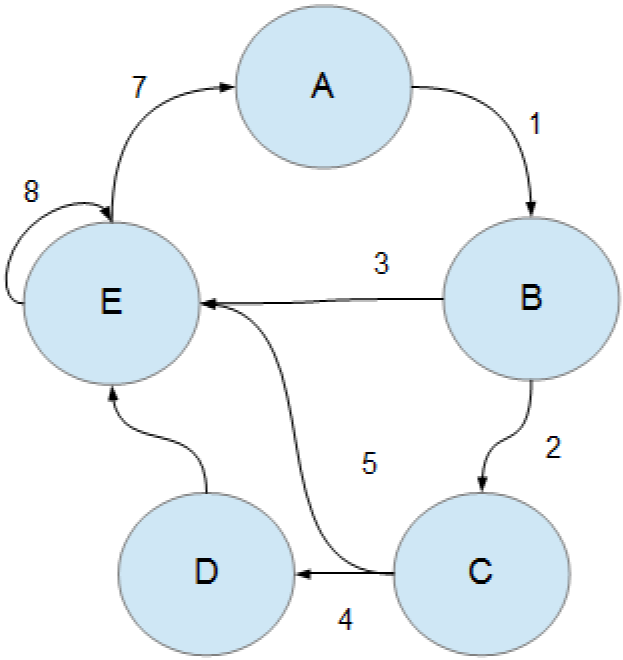


Figure 2.1: Hardware Block Diagram

2.1.2 System State diagram



A: Close door/Check for closed door, wait for distance detection

1: Motion has been detected

B: Wait for bark

2: Bark detected

3: No bark detected for 5 seconds

C: Take pictures, send to user, await response

4: Open command received

5: No command or close command received

D: Open Door

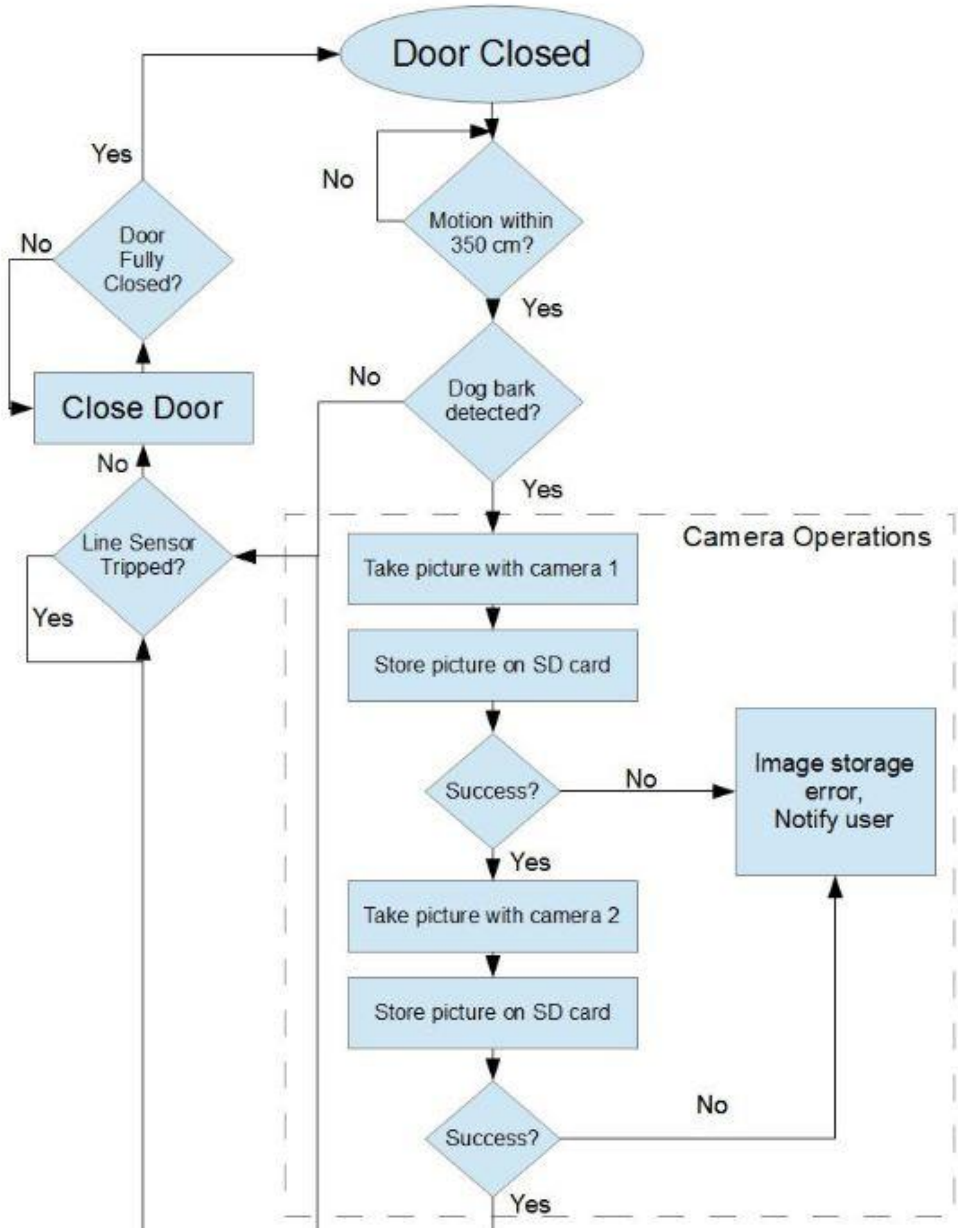
E: Reset timer, wait for line sensor

7: 5 seconds without event

8: Line sensor tripped

Figure 2.2: System State Diagram

2.1.3 Software Flowchart



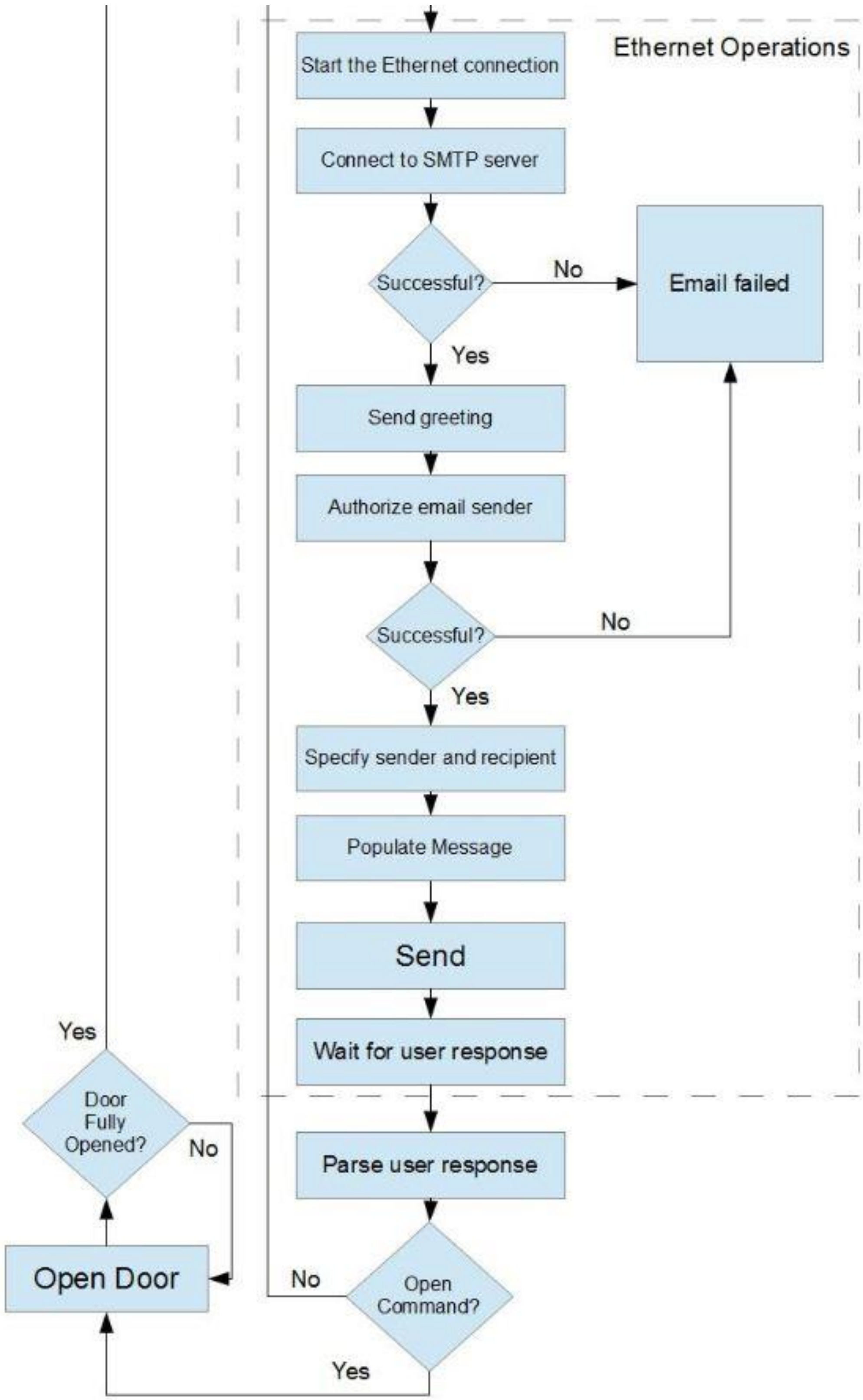


Figure 2.3: Software Flowchart

2.2 Block Descriptions

2.2.1 Overall Summary:

The microcontroller is the central block to the project. It takes in sensory inputs from the distance sensor and microphone to determine if a dog is present and wants to go out. It then takes in pictures from the camera and emails them to the user. Lastly, it takes in sensory inputs from the laser trip wire to sense something blocking the door and stops the close function to prevent harm to people and animals in the pathway of the door. It also outputs to the motor to open and close the door and takes in information from the motor encoder to determine how far the door is open. Each block fits together to create a fully functional system.

2.2.2 Microcontroller:

An Arduino Uno R3 will be utilized as the central processing unit of the design. Corresponding flowchart, and software logic can be found in section 2.4. All the sensors, microphones, cameras, and motor encoder will be fed into the unit as inputs. It will also feed commands to the distance sensor, camera, line trip sensor, and motor shield. Further details of component interaction with the microcontroller are outlined in the respective components subheader.

The microcontroller computes objects' distances from the sensor. When it determines that something is within 350 cm of the sensor, it begins reading the analog input from the microphone. The analog audio input from the microphone is analyzed on the microcontroller. Using FFT analysis, the microcontroller recognizes the dog bark. After it recognizes the bark, it sends a signal to the first camera to take a picture and reads the picture information in serially. It then stores that information on an microSD card mounted on the arduino board. It then repeats this with the second camera.

Using the ethernet shield, the microcontroller will generate a an email containing the two pictures just taken and a prompt requesting a command for the door. It will then wait for a response from the user. If the user does not respond or the user responds with close, the door will stay closed. If the user replies with open, the mechanical opening unit will be initialized. The details of the ethernet shield operations are explained in section 2.2.3.

The microcontroller will send a digital signal to the motor shield which will start the opening process. The arduino will monitor the motor controller until it determines that the door has opened far enough and will signal the motor shield to stop power. This will work in a similar fashion to close the door. While the door is being operated it is monitoring the voltage of the photodiode to determine if anything is in the way of the door.

2.2.3 Ethernet Internet Connection:

An Arduino Ethernet Shield is used to provide internet connectivity to the the board. This will allow the system to send and receive email communications between the board and the user. This will include pictures taken from the cameras and stored on microSD cards as well as text. Text responses will be parsed through to initiate the open signal as well as the close signal if the user wants to ensure that the door is closed. Alerts will also be sent to the user by email to inform the user of possible risks such as the dog not returning after some period of time and an obstruction in the doorway preventing the door from closing.

Once a bark has been detected and the pictures have been taken, the Arduino Ethernet Shield will begin the email notification sequence. First the microcontroller will send the client connect command to connect to the email SMTP server. If this function returns a 1 the connection has been established and it will print “connected” to the serial monitor. Once the connection has been established the microcontroller introduces itself to the server with an EHLO command. The server will respond with a code 250 as well as a list of capabilities offered such as authorization and pipelining for sending multiple commands at once.

Next the Ethernet shield will authorize the email sender with the server by sending the command AUTH LOGIN followed by the username <sender@address> encoded in base64. The server will respond asking for the password for the specified user at which point the shield will respond with the password, also encoded in base64. Successful authorization will lead to the server sending back code 235 authentication succeeded.

After the greetings and authorization are complete the microcontroller will start a new mail transaction. The first step is to specify the sender and recipient using the messages MAIL FROM: <sender@address> and RCPT TO: <receiver@address>. The server will respond to these with code 250 to indicate the sender and receiver have been accepted.

Once these initialization steps have been completed the microcontroller will indicate that it is ready to send the message by issuing the DATA command. The server will respond with code 354 to indicate that it is ready for the message. Then the microcontroller will populate the message with the header lines *From; To;* and *Subject;* followed by an empty line and the body of the message. The images stored on the SD card will be attached to the email using the onboard SD reader of the ethernet shield. To indicate the end of the message the microcontroller sends a single “.” on a separate line. When the “.” is sent the server will check the message for validity and respond with code 250 message accepted. Once the message is successfully sent the microcontroller will send the QUIT command and disconnect from the SMTP server.

After the email is sent to the user the microcontroller will begin polling the inbox awaiting a response from the user. When a new email appears in the inbox the microcontroller will parse the headers and check that the *From;* header matches that of the user. If the <sender@address> does not match the user’s email address the message will be marked as read and the microcontroller will continue polling for a new email. When the ethernet shield receives an email from the user it will parse through the message, remove the *From; To;* and *Subject;* headers and transmit the body of the email to the microcontroller logic for processing.

2.2.4 Distance Sensors:
The distance sensors will be used to detect when something has moved close to the door. The distance sensor operates by sending out an ultrasonic pulse away from the door and listening for an echo. The microcontroller commands the device to send out a pulse every 200 ms through the digital trigger input and analyzes the corresponding wave response through the echo output. The sensor will read high at 5V from the time that the pulse is sent until it returns to the sensor. Using how long it takes for the pulse to return to the sensor and the speed of sound, the object's distance from the sensor can be determined. The below equation is used in the arduino code to determine the distance:

$$\text{distance(m)} = \text{(time duration of high reading)}*(340\text{m/s})/2$$

Using this equation, the microcontroller will determine when something is within 350 cm of the door.

2.2.5 Microphones:
The microphone will be used to record sound and listen for a dog bark. The microphone will be off until the microcontroller determines something is within 350 cm of the door. At that time the microcontroller will send a signal to turn on the microphone on the side of the door that the distance sensor was tripped. The microphone will pick up the audio signal of the surrounding environment and output an alternating voltage waveform. Because the waveform voltage is very low, it will be sent through an amplifier. After the amplifier, the waveform will be sent through a DC offset circuit. The circuit diagram and accompanying equations for this are shown in figure 2.4. This will allow the arduino to read it as an analog input between 0 and 5V.
The audio signal will be interpreted on the microcontroller in order to determine when a dog bark is present. The microcontroller will continuously monitor the surrounding environment audio signal amplitude when an object is detected in front of the door. When a signal amplitude is detected that is far above the average, it will begin sampling the assumed dog bark. The signal will be sampled at a high enough rate in order to adhere to the Nyquist ratio in order to avoid aliasing and corruption.

Nyquist Ratio: $f_s \geq 2f_c$

f_s is the sampling frequency

f_c is the highest frequency contained in the signal

The sampling frequency will also not be too high in order to avoid a slow analysis and going beyond the arduino's memory limit. The microcontroller will then perform a FFT (Fast Fourier Transform) on the audio signal. This will transform the analyzing process from the time domain to the frequency domain. The signal may additionally be windowed if needed. This can aid in excluding unwanted noise and frequencies. The microcontroller will analyze the signal in the frequency domain looking for peaks. It will select the highest peaks within a given frequency range. These peaks will be compared against the pre analyzed sample from the recorded dog bark to find a match. Values for frequency ranges and peak values will be calibrated in order to achieve the goal of less than 40% of positive detections be false positives.

2.2.6 Cameras:

Two cameras will be used to take pictures of the inside and outside of the door. The camera makes use of two digital signals. One signal sends commands to the camera from the microcontroller. The other signal feeds information serially to a digital input on the microcontroller. The microcontroller has the ability to freeze the video stream and download a JPEG image from the camera module. The microcontroller will perform both image captures and store the pictures on a microSD card mounted on the arduino board. Downloading from each camera will be staggered with one after the other to avoid writing to the microSD card simultaneously. The pictures will later be sent to the user via email.

2.2.7 Line Trip Sensors:

The line trip sensors will be used to detect if there is a dog (or any obstruction) in the doorway. The line trip sensors will make use of a 650nm laser diode and a photodiode. The lasers will be powered from the 3.3V power supply of the microcontroller. The photodiode produces an elevated voltage of roughly 2mV when it is hit by the laser, and 1 mV when it is not. The signal from the photodiode will be fed into an analog port on the microcontroller. Using the voltage range, the microcontroller can determine when something is in the way of the door. The photodiodes will be placed into cylindrical casings to ensure that as little ambient light as possible interferes with the sensing.

When the door is initially opened, the microcontroller will wait five seconds for something to break the line trip sensor, signaling the dog has begun to pass through. If nothing passes, the door will close. The microcontroller will also keep track of which of the two trip sensors is blocked first. This can be used to determine whether the dog is going in or out. Most importantly, the trip sensors will make sure the door does not close when the sensors are blocked.

2.2.8 Mechanical Opening Unit:

The mechanical opening unit will open and close a sliding door when prompted by the user. The mechanical opening unit consists of three main subcomponents. The first is the arduino motor shield. When the user commands the door to open, it turns the digital signal into usable power for a motor. The 5V digital signal from the arduino board is converted into a maximum 12V 4A power source. This is used to power the motor.

The motor is a brush DC linear actuator motor that runs at 12V and a max of 2A with a gear ratio of 127.7:1. The door will rest on a split nut. The rotation of the screw moves the split nut device laterally along the aluminum track.

The final piece of the mechanical opening unit is the motor encoder. This sends a two bit digital logic stream to the microcontroller. This stream tells the microcontroller how many rotations the motor has done in ¼ turn increments. This will be used to determine when to stop the motor after the door has opened and closed the correct distance. Necessary dimensional values will be determined pending machine shop build.

2.3 Electrical Design

2.3.1 Circuit Diagrams

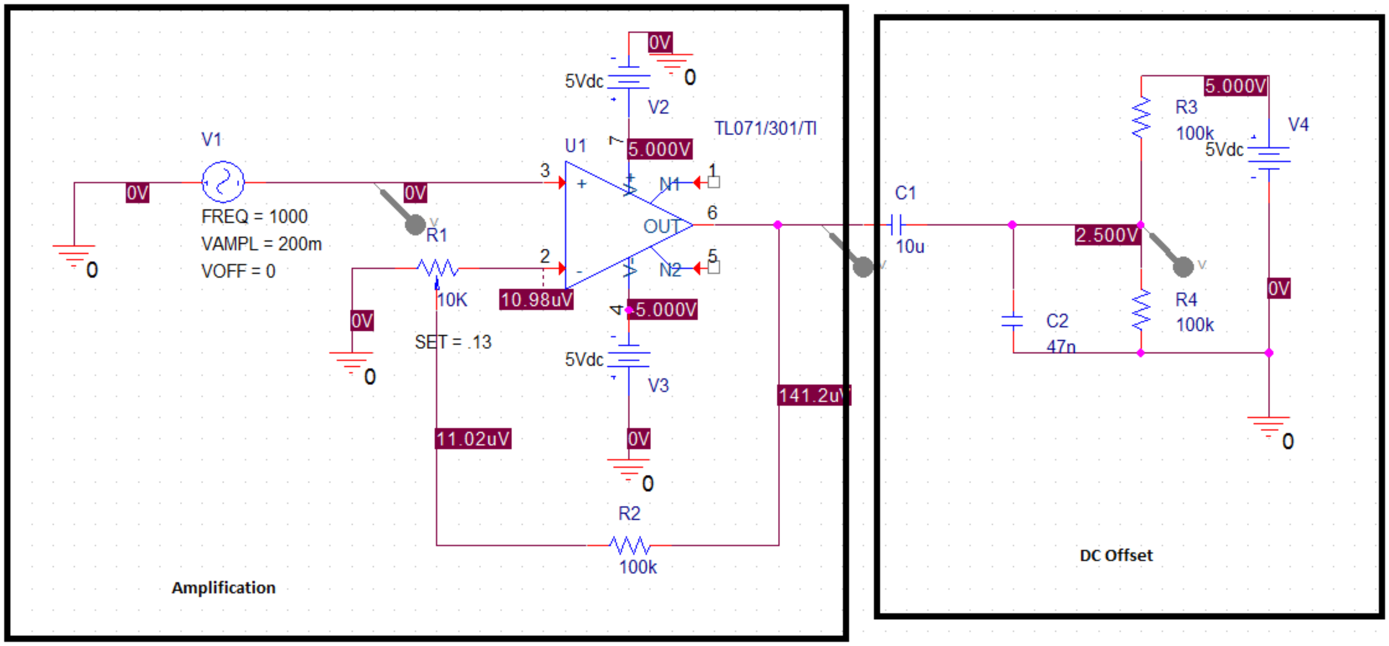


Figure 2.4: Audio amplification(left box) and DC offset circuit(right box)

Amplification:

$V_{amp} = V_{in}(1 + R_2/R_1)$

$.20(1 + 100k/8.7k) = 2.5V$

DC Offset:

$V_{out} = V_{cc}[R_4/(R_4 + R_3)] + V_{amp}$

$V_{out} = 5[100k/(100k+100k)]+2.5=5V$

2.3.2 Pinouts

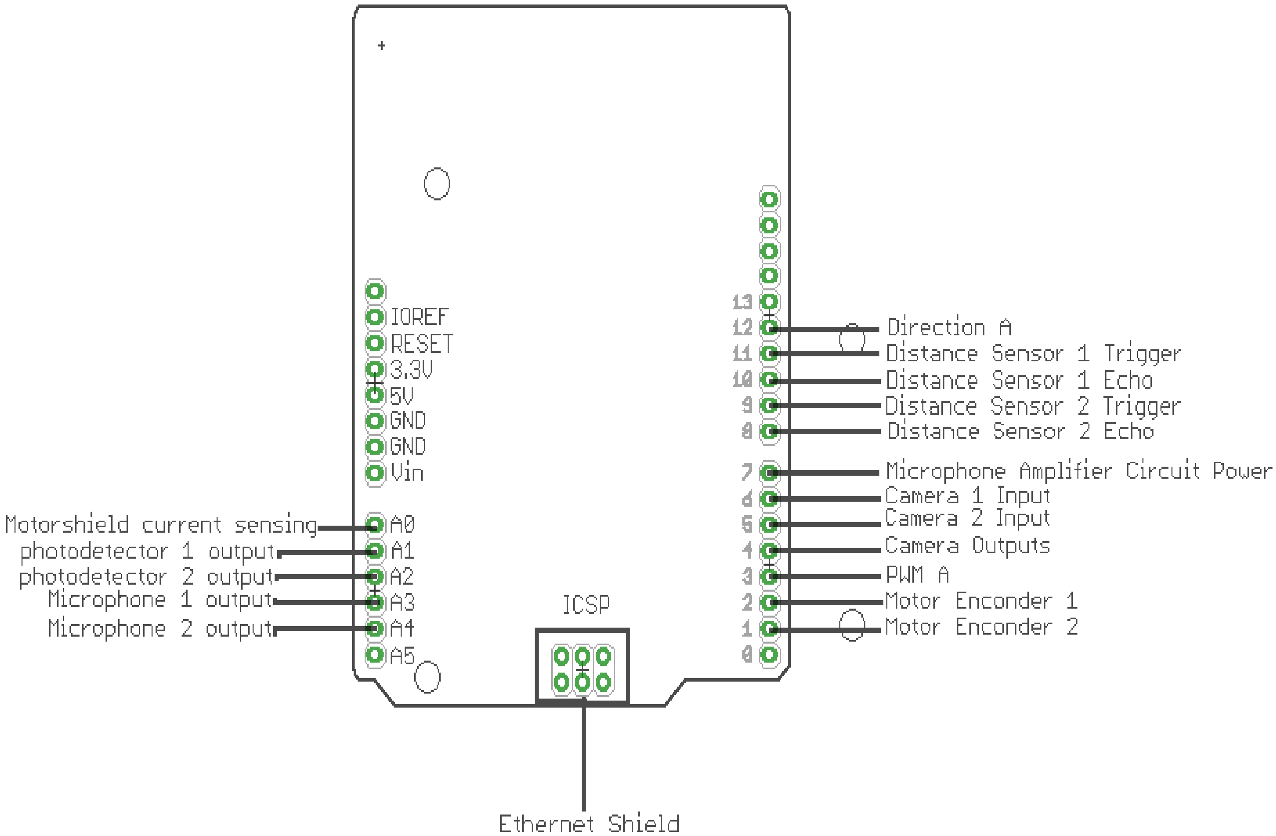


Figure 2.5: Arduino Pin Selections

*The camera, distance sensors, and microphones will all be powered from the 5V arduino pin. The lasers will be powered from the 3.3V arduino pin. Vin will be supplied from the external power adapter specified in the parts section. Vin for the motor shield will be supplied from a separate, more powerful, power adapter and will not be connected to the Vin of the arduino board. Pull up resistors needed for input signals are located within the arduino board and set via code.

2.6 Simulation Results

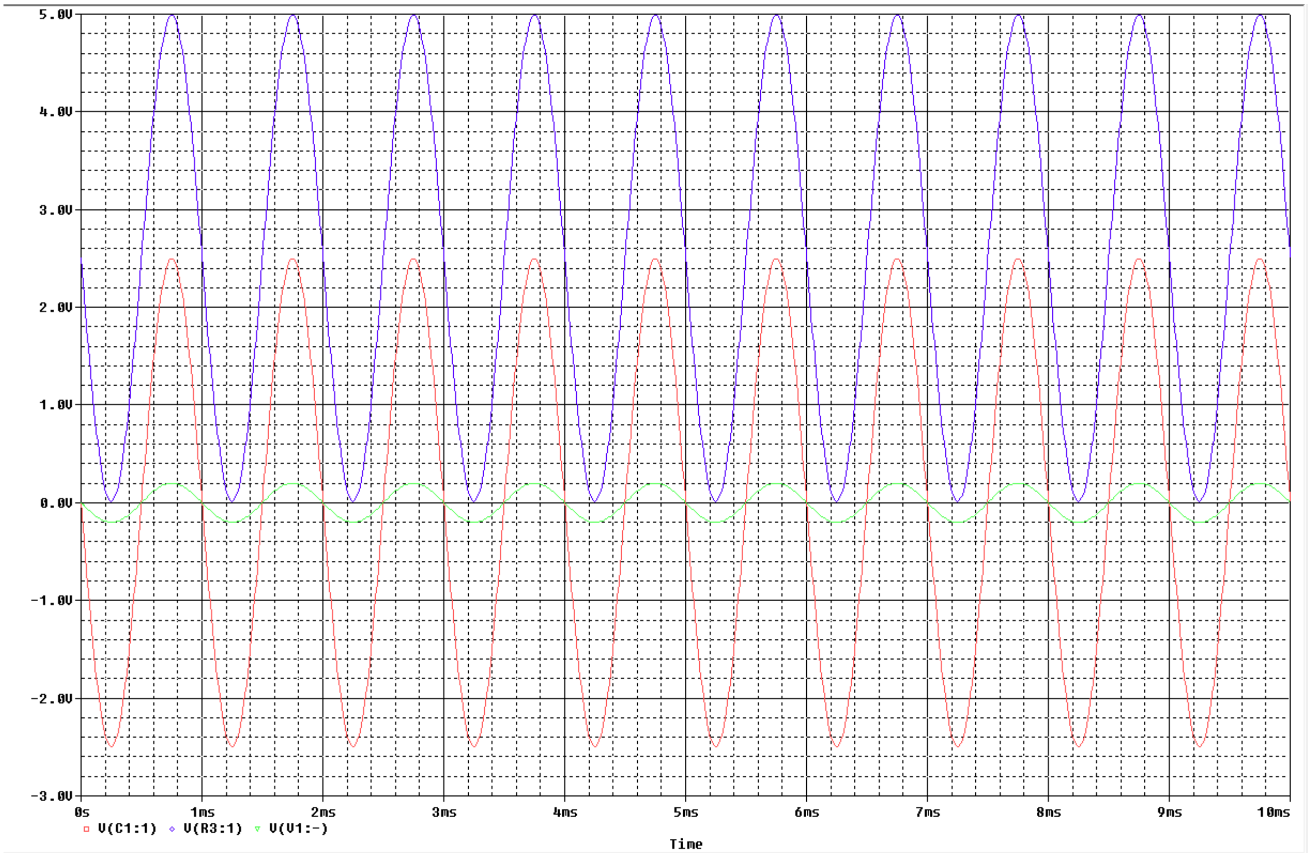


Figure 2.6: Original Audio Signal (lowest peak waveform), Amplified Signal (middle peak waveform), and DC Offset Waveform (highest peak signal)

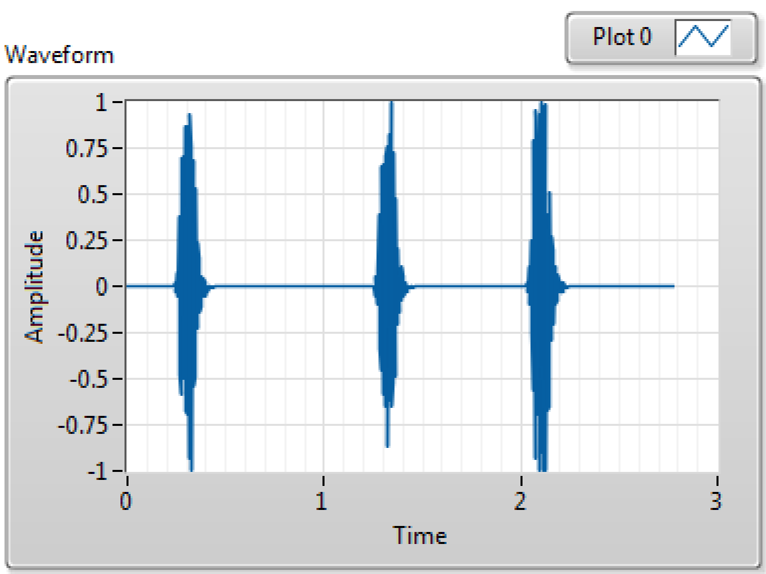


Figure 2.7: Dog Bark Amplitude Waveform

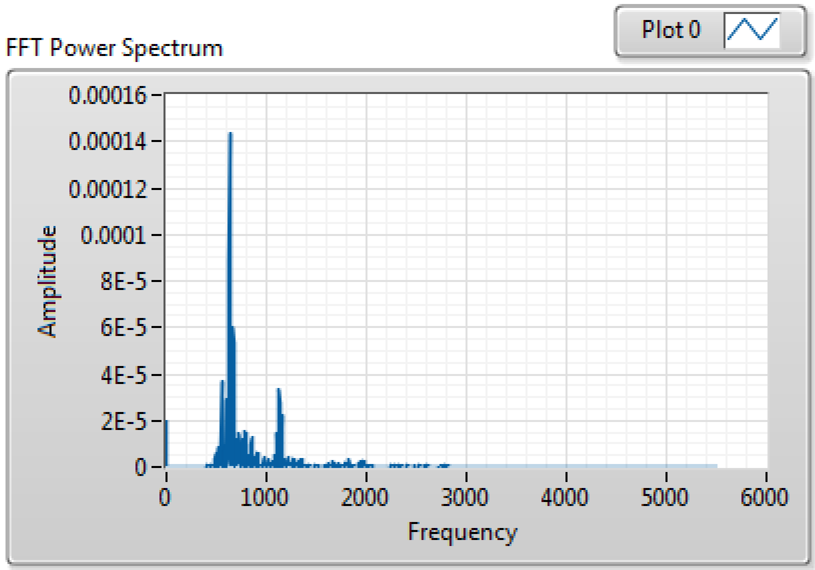


Figure 2.8: FFT Power Spectrum of Dog Bark

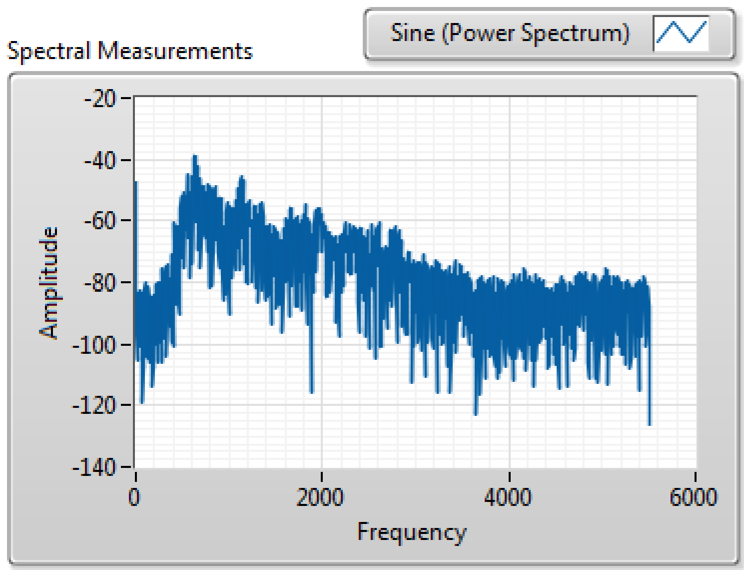


Figure 2.9: Spectral Measurements of Dog Bark

3.0 Requirements, Verification, and Tolerance

3.1 Requirements and Verification

Requirement	**Verification**
1. Motion sensors detects object in front of the door to within 350 cm a. Motion sensor unit is receiving power b. Motion sensor sends transmit signal when triggered by the microcontroller c. Motion sensor receives reflected signal d. Motion sensor unit is grounded	1. An object will be moved in front of the sensor at 50 cm, 200 cm, 350 cm, and 500 cm. Distance readings will be collected from the arduino serial port at intervals of 200 ms and should steady out after two seconds with no more than one third of the readings delivering incorrect values. a. A multimeter will be connected to the Vcc pin and should read 5v ± .2V b. The microcontroller will write digital HIGH to the pin connected to the motion sensor trigger pin. A microphone will be placed in front of the transmitter and plugged into an oscilloscope. We should see a 40 kHz signal on the oscilloscope. c. We will use a multimeter to probe the echo pin on the motion sensor. Shortly after a pulse is transmitted we should see the multimeter read 5V ± .2V d. A multimeter will be connected to the Vcc pin and should read 0 ± .2V
2. Line sensor detects object in its path a. Laser receives power b. Laser sends a signal that is received by the photodetector c. Photodetector voltage noticeably changes when laser is blocked	2. The laser will be aimed at the photodetector. An object will be placed in the laser's path to block the signal. When the beam is blocked the photodetector output voltage rises from 1mV to 2mV. This will be confirmed using a multimeter. a. A multimeter will be connected to the laser power wire. The multimeter should read 5V ± .2V b. A multimeter will be connected to the output of the photodetector. First we will take

	the reading when no laser is pointed at the photodetector. Next we will point the laser at the photodetector. The multimeter shows a reading different than when no laser is pointed at it c. The laser will be powered and aimed at the photodetector. A multimeter will be connected to the output of the photodetector. When the laser beam is blocked the multimeter reading will fall from 2mV ± .005V to 1mV± .005V
3. Both cameras take pictures when prompted a. The camera receives power b. The camera receives the signal from the arduino to take a picture c. The camera is initiated and takes a picture i. camera receives the activation signal ii. The picture can be read from the camera output d. The JPEG picture is downloaded and stored on the microSD card	3. The cameras will take pictures and relay them to the microcontroller when prompted a. A multimeter will be connected to the Vcc pin of the camera. The multimeter should read 5V ± .2V b. When the microcontroller is cued, it will set the digital pin connected to the camera input to high. A multimeter reading of the camera input should read 5 volts. c. Using the serial monitor of the microcontroller, the serial output from the camera to the microcontroller will be confirmed i.The microcontroller will write HIGH to the digital pin connected to the camera RX input pin. A multimeter will be connected to the input pin. The multimeter should read 5V ± .2V. ii. The microcontroller will print data from the output pin of the camera to the serial monitor. After the camera activation signal is sent, we will see a series of 1s and 0s instead of only 0s d. A test JPEG will be sent into the digital pin of the microcontroller serially. The microSD card will be removed. Using a card reader, it will be confirmed that the JPEG was written to the microSD card successfully

4. The audio circuitry captures and manipulates the incoming audio signal properly a. The microphone functions properly i. The microphone is properly grounded ii. The microphone is outputting an audio signal of the surrounding environment b. The op amp amplifies the audio signal i. The op amp is properly powered ii. The op amp is properly grounded iii. The input signal is fed into the op amp iv. The op amp amplifies a signal v. The op amp amplifies the incoming audio signal so the peaks reach 2.5V ± .5V and -2.5V ± .5V c. The DC offset circuit shifts the amplified audio signal to an arduino compatible range of 0-5 V i. The circuit is properly powered ii. The circuit is properly grounded iii. The circuit amplifies a test signal of amplitude 2.5 V to 5V ± .2V iv. The circuit offsets a signal from the microphone and amplifier where the peak amplitudes are from 0 to 5V	4. The audio waveform is displayed on an oscilloscope properly amplified and DC offset a. i. A multimeter will be used to probe the ground pin of the microphone to confirm that it is at 0V ±.2V ii. The output of the microphone will be output to an oscilloscope. The waveform on the oscilloscope should show peaks when loud signals are made to the microphone, such as a clap b. i. The Vcc+ and Vcc- pins of the op amp are probed using a multimeter to confirm it receives 5V± 0.2V and -5V± 0.2V respectively ii. A multimeter will be used to probe the ground pin of the op amp to confirm that it is at 0V ±.2V iii. An oscilloscope will be placed at the output terminal of the microphone as well as the input of the op amp circuit. We will provide audio input and verify that the two signals match. iv. A test signal of amplitude 200mV will be fed into the input of the op amp. The output will be displayed on an oscilloscope showing a gain (Vout/Vin) of 12.5. The should correspond to a peak voltage of 2.5V v. An oscilloscope will be connected to the output of the op amp circuit. We will measure ambient sound as well as a series of louder noises and visually confirm that the peak voltages are 2.5V ± .5V and -2.5V ± .5V c. i. The Vcc node of the circuit will be probed using a multimeter to confirm it receives 5V± 0.2V ii. A multimeter will be used to probe

	the ground node of the circuit to confirm that it is at 0V ±.2V iii. A power supply will be connected to the input of the DC offset circuit and set to 2.5 V. We will use a multimeter to probe the output terminal and verify that it is at 5V± 0.2V iv. The input of the DC offset circuit will be connected to a power supply and an oscilloscope will be connected to the output of the circuit. We will vary the voltage of the power supply and check multiple data points to ensure that Vout = Vin + 2.5 V ±.2V
5. Incoming audio signal from microphone circuit is processed and analyzed for dog bark detection a. Arduino recognizes a loud noise that could be a dog bark b. The arduino performs an FFT on the converted audio signal c. Audio is sampled according to Nyquist ratio limits to avoid aliasing d. The arduino can recognize defined amplitudes in a given frequency range e. The arduino can recognize a dog bark	5. The offset microphone data is processed for bark detection on the arduino board a. The arduino will turn on an LED when a signal is processed whose amplitude is 1V ± .1V higher than the surrounding environment b. A test audio signal will be sent to the arduino. The arduino will perform an FFT. The arduino will serially output the result of the FFT to confirm that it is performed properly c. The audio signal being input to the arduino will be observed on an oscilloscope. The peak amplitude will be recorded. The sampling rate used by the arduino must match the nyquist rate corresponding to this peak amplitude d. A frequency band of 10kHz will be used. An input test audio signal in that given range whose amplitude is above 2V ± .5V will set off an LED e. A pre-recorded audio signal of a dog bark will be sent to the arduino. The arduino should recognize the signal and turn on an LED 50% of the time. The LED should not turn on when the arduino is sent a test signal of the surrounding environment

6. Motor opens the door a. The motor shield receives activation signal from the microcontroller b. The motor is activated c. The motor opens the door d. The mechanical encoder outputs the correct output bits corresponding to the length the door has opened e. The door stops when something is in its path	6. The door opens when prompted a. The digital microcontroller output connected to the input of the motor shield will be set to high. Using a multimeter, verify that the input voltage seen by the motor is equal to 12V. b. When the input of the motor is set to 12V, the motor spins without a door attached c. The door is opened all the way by sufficiently sending 12V at a max of 2A from the motor controller d. The two bit output of the mechanical encoder will be monitored using the microcontroller's serial monitor. The nut moving the door will be moved slowly by the motor. The measured distance the nut moves on the lead screw should match the calculated distance from the amount of turns signaled by the encoder bits. Values will be determined pending machine shop build. e. An object will be placed in the path of the door. Using a multimeter the current being sent to the motor will be monitored. When the current is elevated by 25%, because of something stuck in the door, the arduino will stall the motor
7. Microcontroller sends email with pictures attached, receives and parses email response with user instructions a. The microcontroller successfully sends an email to the user with pictures attached i. Microcontroller connects to SMTP email server ii. Microcontroller successfully authenticates to SMTP server with username and password iii. Email body is formed iv. Pictures are attached	7. User receives email with pictures, appropriate signal is sent to the motor given user response a. The email and pictures will be received on the user's phone i. The client.connect function returns a 1 (success) and print statements will be used to print "connected" to the serial monitor ii. Server responds with code 235 authentication succeeded iii. Server responds with code 250 to

b. Microcontroller receives email with user response and produces appropriate signal to send to mechanical opening unit i. Email is received by Microcontroller ii. Microcontroller reads in body of email iii. based on email text, open or close signal is produced	indicate the message has been accepted iv. Server responds with code 250 to indicate the message has been accepted. Test images will be used that were saved on the microSD card using a computer and card reader b. Email will be sent to microcontroller with open and close commands, correct signal is produced i. Using SMTP polling and a test LED, microcontroller will light up an LED when unread messages are present in inbox ii. Using serial print statements, microcontroller will print body of email to serial monitor iii. Serial monitor will print value of digital pins 3 and 12 which are used for motor control. High and low output values (0 and 5V) will correspond to open or close command in email

3.2 Tolerance Analysis

The core functionality of the project is to detect the bark of a dog through ambient noise and limit the number of false positives. With every positive detection of a dog bark an email will be pushed to the user. This could potentially become a nuisance if the system detects too many events that appear to be dog barks. Our goal is to have less than 40% of positive detections be false positives. This should be a reasonable goal considering the difficult nature of the DSP, a dog’s varying bark amplitude and frequency response and the low cost equipment being used.

4.0 Safety

The main safety concern for this project is the dog using the door. Since everything is remotely controlled there is a potential hazard of the door closing on the dog. Since the door will potentially be used by others, including small children and other humans, it must also be safe for varying user types. We have included multiple safety precautions to prevent any injury. The main way injury will be prevented is by the laser trip wire sensors. These sensors will be continuously running when the door is open. When something blocks the path of the laser, implying someone or something is still in the doorway, the microcontroller will stop the door from closing. There will be two separate laser trip wires for the purpose of sensing which way the dog is going. This will also add a level of redundancy in case one of the sensors fail.

Our second concern for safety is letting in unwanted people or other animals. When the system is initialized by the motion sensor and dog bark, pictures of what is on both sides of the door will be sent to the user via email. The cameras allow for the user to see what could potentially pass through the door when it is opened. If the dog is barking at another animal or an unknown person on the other side of the door, the user has the ability to not open the door. Additionally, using the two laser system, it will be known that a dog initializing the door to open from one side of the door is leaving from that side of the door. In the event that an intruder enters the doorway after the dog initializes the open sequence from one end of the door an alert will be set off and a warning message will be sent to the user.

The final safety concern is safe operation of electricity dependent devices. The highest power device being used in this project is the motor. The maximum amount of power that can be generated by any of the devices is 12V at 4A by the motor shield. This has the potential to slightly harm a person.

5.0 Ethical Issues

1.) To accept responsibility in making decisions consistent with the safety, health, and welfare of the public, and to disclose promptly factors that might endanger the public or the environment;

The project involves automatically opening a door which has some risk involving the safety of people or animals crossing the path of the door. We have implemented several safety measures to ensure the safety of the user. We will fully disclose any possible safety risks or design flaws to the user.

3.) To be honest and realistic in stating claims or estimates based on available data;

The digital signal processing of a dog bark is a challenge and we must be realistic in assessing the reliability of the system with this component. Through thorough testing of subcomponents of the system and the system as a whole, we will provide realistic statistics regarding the reliability of the system.

7.) To seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others;

We will incorporate all the criticism of Professor Carney, TA's, other students, and anyone else helping with our project. We will also credit in the reference section any other person's work or ideas that have aided our design in any way.

6.0 Cost Analysis and Schedule

6.1 Cost Analysis

Part Description	Part Number	Manufacturer	Price	Quantity	Total
Arduino Uno R3	Uno R3	Arduino	$29.95	1	$29.95
Arduino Power Source		NKC Electronics	$6.49	1	$6.49
Motor Power Source 12V 2A	PSAD24	Logists	$7.99	1	$7.99
Arduino Ethernet Shield R3	ETH Shield 06	Arduino	$40.01	1	$40.01
Microphone	CEM-C9745JAD463P 2.54R	Challenge Electronics	$0.95	2	$1.90
Arduino Motor Shield R3	R3	Arduino	$29.95	1	$29.95
Ultrasonic Module Distance Sensor	HC-SR04	Elec Freaks	$5.78	2	$11.56
650nm 5mw 3.2VDC Laser	TO-18	Aixiz	$9.56	2	$19.12
Photodiode 850nm 0.62A/W	BPW 34	Opto Semiconductors	$0.99	2	$1.98
Motor	GM9213C177-R1	Pittman	$158.00	1	$158.00
Mechanical Encoder	Series 25L	Grayhill	$5.84	1	$5.84
Op-Amp	TL 071	Texas Instruments	$0.67	1	$0.67
Resistors		Panasonic	$0.15	15	$2.25
10uF Electrolytic Capacitor	ECE-A1HKA100	Panasonic	$0.20	1	$0.20

47nF Ceramic Capacitor		TDK	$0.10	1	$0.10
MicroSD card 2GB		SanDisk	$4.45	1	$4.45
Serial Camera Module	PTC08	Putal	$39.95	2	$79.90
Ethernet Cable 50ft		MediaBridge	$9.49	1	$9.49
LED	TLHG4400	Vishay	$0.54	3	$1.62
Aluminum Tracks	N/A	Machine Shop	$10.00	1	$10.00
Lead Screw	N/A	Machine Shop	$5.95	1	$5.95
Momentary Switch	COM-09190	Sparkfun	$0.50	1	$0.50
Split Nut	N/A	Machine Shop	$10.00	1	$10.00
				Parts Total	**$437.92**
Name	**Rate(dollar/hr)**	**Hours**	**Total**		
Devraj Banerjee	$40.00	200	$8,000.00		
Ryan Madigan	$40.00	200	$8,000.00		
Miles Cernauskas	$40.00	200	$8,000.00		
		Labor Total	**$24,000.00**		
Parts Total	**$437.92**				
Labor Total	**$24,000.00**				
Grand Total	**$24,437.92**				

6.2 Schedule

Week	**Task**	**Team Member Responsible**
2/18/2013	Design line trip sensor system	Miles
	Design distance sensor system	Devraj
	Design mechanical opening unit circuit	Ryan
2/25/2013	Design microphone amplification and offset circuit	Ryan
	Record dog barks, initial analysis of characteristics to be used for detection	Devraj
	Prepare Design Review	Miles
3/4/2013	Write code for bark recognition	Miles
	Design and test email notification method	Devraj
	Test microphone amplification/offset circuit and submit PCB	Ryan
3/11/2013	Write and test code for proper output based on test sensory input	Miles
	Test bark recognition on microcontroller using microphone and circuit	Ryan
	Cameras take pictures, store them on Arduino SD card	Devraj
3/18/2013	Spring Break	Ryan, Miles, Devraj
3/25/2013	Test that the microcontroller sends email containing pictures, receives email from user, and parses correctly	Miles
	Prepare mock up demo	Devraj

	Construct doggie door and set up mechanical opening unit	Ryan
4/1/2013	Finalize and test all code	Miles
	Test that email from user opens door	Devraj
	Set up sensory system for proper functionality on the doggie door	Ryan
4/8/2013	Set up and test that full system functions properly together	Miles
	Test project on actual dog	Devraj
	Fit project into enclosures and make aesthetically pleasing	Ryan
4/15/2013	Finalize Project	Miles
	Prepare Demo	Ryan
	Sign up for demo and presentations	Devraj
4/22/2013	Finalize Presentation	Devraj
	Finalize Paper	Miles
	Confirm all deliverables are turned in on time	Ryan

6.3 Contingency Plan

The DSP work involved with the dog bark is the most likely to be non functional. In the event that the microcontroller is not able to recognize the dog bark from the incoming audio signal, there is a contingency plan. We will slightly modify our project in order to show partial functionality of the audio processing and complete functionality of the remaining project. The rest of the project will function in the same manner as described throughout this paper.The audio recognition will be changed to recognize a loud noise. If the amplitude of the audio signal is above a certain threshold, the microcontroller will recognize it as a bark. This is assuming that dog barks are usually much louder than surrounding sounds. Although this is not full functionality, it will show functionality of most the project.

7.0 References

1) Texas Instruments, “Low-noise JFET-input operational amplifier” TL071 datasheet, Sept. 1978 [Revised Mar. 2005].

2) A. Sedra and K. Smith, *Microelectronic Circuits, 6th ed.*, Oxford University Press, 2010.

3) Che Yong Yeo, “Dog voice identification (ID) for detection system,” In Proc. IEEE Second International Conference on Digital Information Processing and Communication, 2012, pp.120-123.

4) Pittman, “Lo-Cog DC Gearmotor” GM9413-2 datasheet, 2001.

5) Elec Freaks, “Ultrasonic Ranging Module” HC-SR04 datasheet.

6) Arduino, “Arduino Uno Overview,” [Online].
Available: http://arduino.cc/en/Main/arduinoBoardUno

7) Arduino, “Arduino Uno Rev3” R3 datasheet.

8) Arduino, “Arduino Motor Shield Overview,” [Online].
Available: http://arduino.cc/en/Main/ArduinoMotorShieldR3

9) Arduino, “Arduino Motor Shield” datasheet.

10) Arduino, “Arduino Ethernet Shield Overview,” [Online].
Available: http://arduino.cc/en/Main/ArduinoEthernetShield

11) Arduino, “Arduino Ethernet Shield” Arduino Eth Shield 06 datasheet.

12) Grayhill, “Mechanical Encoder” 25L datasheet.

13) AiXiZ, “650nm 5mW LASER Diode” TO-18 datasheet.

14) Putal, “Serial Camera Module” PTC08 datasheet, Sept. 2009.

15) Challenge Electronics, “Omni-Directional Foil Electret Condenser Microphone” CEM-C9745JAD462P2.54R datasheet, 2010.

16) Jameco, “PIN Photodiode” BPW 34 datasheet, 2007.

17) Fehcom, SMTP Authentication. [Online]. Hohn, Germany, 2013.
Available: http://www.fehcom.de/qmail/smtpauth.html#top

18) Wikipedia, “Simple Mail Transfer Protocal,” Wikipedia. [Online].
Available: http://en.wikipedia.org/wiki/Simple_Mail_Transfer_Protocol